ZOOLOGICAL SERIES
OF
FIELD MUSEUM OF NATURAL HISTORY

Volume XX | CHICAGO, OCTOBER 31, 1936 | No. 17

GUATEMALAN SALAMANDERS OF THE GENUS OEDIPUS

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The Mandel Guatemala Expedition of Field Museum of Natural History was in the field from November 24, 1933, to April 21, 1934. My own share in this expedition was financed by funds from a fellowship of the John Simon Guggenheim Memorial Foundation. Due to the generous support of Mr. Leon Mandel II, of Chicago, it was possible to add Mr. Emmet R. Blake as field collector for birds and my brother, the late F. J. W. Schmidt, of the University of Wisconsin, for mammals. Mr. Daniel Clark, of Arlington Heights, Illinois, joined the expedition as volunteer assistant. With the aid of these assistants and that of our cordial friends in Guatemala, considerable success attended the collecting of reptiles and amphibians, which was pursued at some fifteen stations. In this collection, much the most notable element consists of 731 specimens of the salamanders of the genus *Oedipus*. These come from the volcanoes Agua, Atitlan, and Tajumulco, from the central highland at the Sierra Santa Elena, from the mountains of Alta Verapaz, and from the Atlantic lowland at Escobas, the site of the water supply for Puerto Barrios. My brother took a special interest in collecting these salamanders with me, and was keenly interested in their zonal arrangement on the volcanoes. The collection from the Volcan Atitlan is entirely due to his efforts. It is the purpose of the present paper to offer remarks on the species of the genus *Oedipus* hitherto known from Guatemala and to describe the new forms which result from our collecting.

In a more extensive report on the herpetological collections it is hoped that an itinerary of the expedition may be given, and our thanks extended to every one in the long list of friendly Guatemalans, and of Americans and Germans resident in Guatemala, whose aid contributed to our success. On the present occasion I wish to thank

especially Mr. and Mrs. Teodoro Engelhardt and their son, of Olas de Moca; Mr. and Mrs. Axel Pira, and their sons and daughter, of Santa Elena; Mr. and Mrs. Gustav Helmrich, of the Finca Samac;

FIG. 13. Map of Guatemala, with collecting stations of the Mandel Guatemala Expedition.

Don Arturo Mondal, of Puerto Barrios; and Dr. H. Goebel, of the Central American Plantations Company headquarters in Guatemala City. It was at Dr. Goebel's invitation that we visited the great coffee plantation El Porvenir, at the foot of the Volcan Tajumulco,

where we were most cordially entertained by the manager, Mr. Erich Zoller, and his aids.

Through the Guggenheim Fellowship a preliminary study of Guatemalan material in European museums was made possible. In the course of studies on the genus *Oedipus* I was especially indebted for friendly aid to Mr. H. W. Parker, of the British Museum (Natural History); to Mr. F. Angel, of the Museum d'Histoire Naturelle, in Paris; to Dr. Jean Roux, of the Naturhistorisches Museum in Basel; and to Dr. Lorenz Müller, of the Zoologische Staatssammlung in Munich. Through the courtesy of Dr. Leonhard Stejneger, of the National Museum, the fifteen specimens of Guatemalan species in that museum were loaned for the purpose of the present study. Mr. Joseph R. Slevin, of the California Academy of Sciences, has very kindly forwarded a part of his own extensive collections of salamanders, made in Guatemala in 1924 and 1926, together with the few additional specimens collected by Mr. F. X. Williams in 1934. Three specimens collected in Peten by Mr. Harry Malleis and now in the Museum of Zoology of the University of Michigan, were called to my attention by Dr. L. C. Stuart.

I am indebted to my colleague, Mr. Paul C. Standley, for identification of the few plants brought to the Museum from the Volcan Tajumulco. Almost needless to add, I have corresponded on the topic of the present paper with my friend Dr. E. R. Dunn, of Haverford College, the principal authority on these salamanders, as on the salamanders of the world, and I am indebted to him for ideas and criticism.

The first *Oedipus* to be described from Guatemala was included in the description of *Bolitoglossa mexicana* by Duméril and Bibron in 1854. The next Guatemalan specimen to appear in museum collections was named *Oedipus salvinii* by J. E. Gray in 1868; it bore no exact locality. In the following year Cope described *Oedipus morio* from the highland of Guatemala; and *O. rufescens* in the same paper, from Orizaba, Mexico, a species since traced into Guatemala. Bocourt's Guatemalan collections contained a considerable number of salamanders, and four new species were described by Brocchi in 1882. These are *attitlanensis*, which is an exact synonym of *salvinii; bocourti*, which I regard as identical with Cope's *morio;* and *rostratus* and *mülleri*, which I regard as valid forms. Brocchi also records a specimen from the Rio de la Pasion, Alta Verapaz, without describing it. This and one of his specimens of *mülleri* appear to represent the widespread lowland form *platydactylus*, which can be distinguished

at least as a subspecies in Peten and British Honduras. To this I am provisionally applying the name *mexicanus*, Duméril and Bibron. Both Cope and Brocchi record an elongate species from Guatemala under the name *vermicularis*, and Brocchi figures a specimen. These records represent the species described as new in the present paper under the name *elongatus*. Günther's list of the species of this genus in the volume on Reptilia and Batrachia in the *Biologia Centrali-Americana* gives no new information on Guatemalan species except for the figure of what he regards as a "variety" of *Oedipus variegatus* from the Pacific coast of Guatemala. In 1921, Dunn described the very distinct free-toed species *Oedipus rex* from Guatemalan collections made by C. M. Barber at Santa Elena in 1905. A complete revision of the genus is included in Dunn's volume *The Salamanders of the Family Plethodontidae* published in 1926, since which time no reference to the species found in Guatemala has appeared. I have for the present avoided the use of trinomials, since much collecting remains to be done before a satisfactory distinction between the forms which are representative geographic races and those which are otherwise distinguished can be made. With the new forms in the present collection, this history results in the following list of species for Guatemala:

Species	Type locality
Oedipus mexicanus (Duméril and Bibron)	Dolores, Peten
Oedipus salvinii Gray	Guatemala
Oedipus flaviventris sp. nov.	Chicharras, Chiapas
Oedipus mülleri (Brocchi)	Alta Verapaz
Oedipus rufescens Cope	Orizaba, Vera Cruz
Oedipus helmrichi sp. nov.	Samac, Alta Verapaz
Oedipus morio Cope	highland of Guatemala
Oedipus rostratus Brocchi	heights above Totonicapan
Oedipus engelhardti sp. nov.	Volcan Atitlan, 7,000 feet
Oedipus flavimembris sp. nov.	Volcan Tajumulco, 7,200 feet
Oedipus franklini sp. nov.	Volcan Tajumulco, 5,600 feet
Oedipus bromeliacia sp. nov.	Volcan Tajumulco, 8,000 feet
Oedipus goebeli sp. nov.	Volcan Tajumulco, 8,000 feet
Oedipus rex Dunn	Santa Elena, 9,500 feet
Oedipus elongatus sp. nov.	Escobas, near Puerto Barrios

GEOGRAPHIC AND VERTICAL DISTRIBUTION

Positive information as to the vertical range of the species of *Oedipus* in Guatemala is now available only for the Tajumulco species, and even for these much additional investigation will be necessary before the zonal arrangement can be discerned with accuracy. The geographic distribution is even less adequately known. The present remarks consequently afford no more than a tentative outline of an interesting topic, which is to be corrected and filled in by future study.

The Volcan Tajumulco was an ideal base for studies of vertical distribution. Not only is it the highest and most massive of the Guatemalan volcanoes, but it proved to be by far the most readily accessible. The comfortable quarters provided for us at the plantation El Porvenir, at the base of the mountain, were supplemented by the existence of a mountain cabin at 10,400 feet, in the heart of the balsam zone, seven thousand feet above. This had been built by some former German manager of the plantation to facilitate trips to the peak, much after the custom in South Germany and Switzerland. We were thus provided with an excellent base for work at higher altitudes, connected by a good trail with the plantation below. On this trail, with barometer in hand, I marked trees at intervals of five hundred feet. On repeated trips from plantation to cabin and back I was thus able to make some attempt at quantitative collecting at successive altitudes.

The correlation of the vertical distribution of the nine species on the Pacific slope of Tajumulco as at present known, with the "life zones" customarily in vogue for the discussion of altitudinal distribution in the tropics is shown in the accompanying diagram (fig. 15). The principal zones are quite well marked by distinctive vegetation. The ceiba tree characteristic of the lowland plain is absent in the coffee zone. Coffee planting is so strictly confined between two and five thousand feet and is so extensively developed along the whole Pacific escarpment of the Guatemalan plateau that it is customary to speak of the "coffee zone," which forms a natural division of the tropical zone, thus regarded as including the lower five thousand feet of the slope.

At about five thousand feet the vegetation changes notably, with a great increase especially of tree ferns and of epiphytes and a greater luxuriance of vegetation in general due to the formation of clouds at this level from the upwardly deflected landward winds. This cloud-forest zone, the "subtropical" of F. M. Chapman and others, extends to 9,500 or 10,000 feet. The tree ferns decline greatly in numbers above 7,500 feet and the curious mano de mico tree (*Chiranthodendron pentadactylon*) appears above that level, ranging to 9,500 feet. Above 8,500 feet there is an increase of bamboo in the undergrowth; this forms dense thickets at the upper border of the cloud forest and thus helps to define the border between the subtropical and the succeeding temperate zone. The last thousand feet of the subtropical zone exhibits a transition to a more temperate type of forest in the appearance and even predominance of birch.

FIG. 14. View of Volcan Tajumulco from El Porvenir.

A few scattered pines appear as low on the slopes as 8,500 feet, but these are much too obviously isolated to obscure the essentially sharp lower border of the temperate zone at about ten thousand feet, where a pine and balsam forest in roughly equal mixture succeeds the hardwood and bamboo. The balsams (*Abies religiosa*) are large, with trunks as much as four feet in diameter, and the pines are also large trees. The balsams prove to be confined to a narrow zone, disappearing at 11,000 feet. A considerable woody undergrowth is present in the pine-balsam zone, in which the yellow-flowered bush *Senecio acutangulus* is especially conspicuous, together with *Fuchsia thymifolia* and *Holodiscus fissus*. Herbaceous plants include various *Senecios* and other composites, and such handsome flowers as *Pentstemon gentianoides*. Above the level of the balsams the pines continue in an open growth with grasses, such as *Trisetum spicatum*, lupine, *Lupinus aschenbornii*, and various other plants of temperate affinities, among which *Centropogon affinis*, *Salvia cinnabarica* and the heath *Gaultheria parvifolia* may be mentioned.

The very conspicuous parasite on the pines, *Arceuthobium vaginatum*, does not appear below 11,500 feet. The open stand of pine, with very little woody undergrowth, continues to 12,500 or 13,000 feet, with occasional clumps of alder (*Alnus jorillensis*). The pines are more and more sparse and stunted in the last 500 feet and except where there is some protection from the wind, timberline may be said to be at 13,000 feet. Above this level the bare rocks of the two peaks rise to 13,400 and 13,870 feet respectively. A most characteristic alpine plant, the stemless daisy-like *Werneria*, blooms in profusion among the rocks at this level. This treeless windswept zone corresponds to the paramo zone of the Andes; but being confined to the isolated peaks of the volcanoes, and lacking geographic continuity either to the north or south, it does not have the distributional importance of the Andean paramo or the Rocky Mountain boreal zones.

The moisture requirements of salamanders make the relatively constant humidity of the cloud-forest an ideal habitat for them. It is consequently not at all surprising that four species, *engelhardti*, *franklini*, *bromeliacia* and *flavimembris* are confined to this zone on Tajumulco, and that the population of a fifth, *goebeli*, falls mainly within it. Nor is it surprising that within this zone three species have adopted the favorable habitat niche afforded by the bromeliad epiphytes. The terrestrial habitat preference of *flavimembris* and the moist-rotten-log niche in which *goebeli* is characteristic are de-

scribed below. *Oedipus goebeli* slightly overlaps the lower limits of the temperate zone, but was not found above 10,500 feet, and is greatly outnumbered there by *Oedipus rex*, which is not found below the balsam forest, and which ranges to 12,700 feet in the temperate zone.

In the accompanying diagram of vertical distribution, the zonal relations of these species are illustrated by figures whose vertical extent indicates their range in altitude, while their lateral width represents the relative abundance of the species. Dotted lines indicate inadequate data.

The species of the tropical zone at the base of the mountain are *rufescens*, which was found exclusively beneath the leaf-sheaths of bananas in the coffee plantation, at about 3,400 feet altitude; *salvinii*, which is a species of the coffee zone on the Volcan Zunil, with a terrestrial habitat; and *flaviventris*, which is known from the tropical zone in Chiapas and the Isthmus of Tehuantepec, and is known to occur in the banana-raising zone in the Guatemalan Pacific coastal plain. Thus, with the interpolation of *salvinii* and *flaviventris* in the Tajumulco series, there are nine species of *Oedipus* in the vertical section from sea level to 13,000 feet on the Pacific slopes of the Guatemalan volcanoes. These species are rather sharply assorted according to the vegetational zones, and are even more rigidly assorted into specific habitat niches. Although *goebeli* and *rex* appear to be closely allied, and certain juvenile specimens are distinguishable with difficulty, I feel sure that they are distinct species rather than subspecies. *Oedipus salvinii* and *O. flaviventris* may well be races assorted by altitude zones. The remaining five species, whatever their relations to forms in other parts of Guatemala, are all mutually distinct on Tajumulco.

Of the plateau species, *Oedipus morio* appears to be strictly associated with the oak-pine forest. This is not represented on the south face of the volcanoes, which explains the absence of *morio* on Tajumulco in the area investigated. *Oedipus rostratus* is so intimately associated with *rex* at Santa Elena that it is surprising to find *rex* alone on Tajumulco. It seems likely that *rex* has reached the temperate zone on the volcano from the plateau, i.e. from the rear, and that it is not an autochthonous member of the cloud-forest fauna.

Including the lowland at its base, the number of species recorded from Mount Orizaba, on the escarpment of the Mexican plateau,

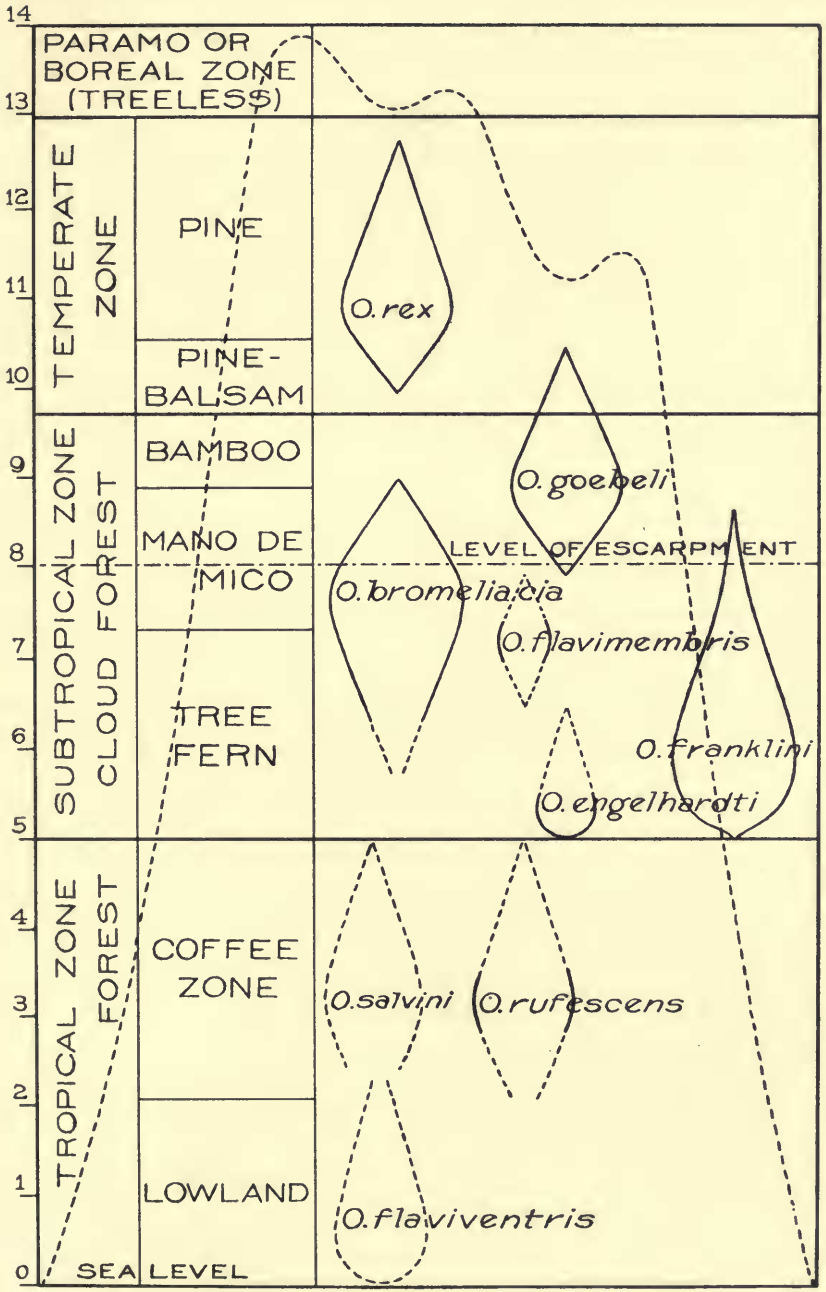

FIG. 15. Vertical distribution of the species of *Oedipus* on the Volcan Tajumulco, with vegetation zones (see text).

equals the Tajumulco series. The nine species known from Vera Cruz are:

Species	Altitude zone
Oedipus platydactylus (Cuvier)	lowland
Oedipus rufescens (Cope)	lowland
Oedipus lineolus (Cope)	lowland, 4,400 feet
Oedipus townsendi Dunn	4,400 feet
Oedipus chiropterus (Cope)	4,000–10,000 feet
Oedipus bellii (Gray)	lowland to 6,000 feet
Oedipus pennatulus (Cope)	8,000–10,000 feet
Oedipus cephalicus (Cope)	8,000–13,000 feet
Oedipus gadovi Dunn	6,000–14,000 feet

So far as present information goes, the first four of these are confined below 5,000 feet, but *lineolus* and *townsendi* are known only from Jalapa, at 4,400 feet, and may not descend to the coastal plain; *bellii*, found at 4,400 feet on Orizaba is replaced at 8,000 (or below) by *gadovi; chiropterus* is known from 4,000 feet to 10,000 feet; and *pennatulus* and *cephalicus* are unknown below 8,000 feet. The zonal arrangement is far less clear in this series than on Tajumulco; but I believe the inference is justified that renewed collecting on Orizaba, with this problem in mind, would afford interesting distributional data, as well as the counter-inference that my data from Tajumulco require much further observation, especially at different seasons. None of the Mexican species are confined to Orizaba, but are found elsewhere along the escarpment of the Mexican plateau. The two escarpments clearly exhibit two distinct faunas. Only the lowland *rufescens* connects the ranges of the two series. The correspondence between the remaining forms is far from clear. There are two small species with enlarged nostrils in the Mexican series and only one in Guatemala. Dunn regards *schmidti* and *robustus* as representative of the Mexican *bellii;* if this is correct, there is no species clearly representative of *bellii* on the Guatemala escarpment. *Oedipus goebeli* is plainly allied to *Oedipus cephalicus*. The worm-like forms are represented in southern Mexico, but are not known from the Pacific side.

The three species known from the Sierra Merendon in Honduras, *schmidti, dunni*, and *nasalis*, will probably be traced along this range into Guatemala. *Oedipus dunni* appears to be closely related to *O. rostratus* and *O. engelhardti* of the Pacific escarpment, while *O. nasalis* is closely allied to *bromeliacia*. It is none the less evident that the Merendon cloud-forest is another independent center of evolution in this genus.

The geographic range of the forms on the Guatemala escarpment is no less interesting than their vertical arrangement. It was at first

highly surprising to collect a single easily recognizable specimen of *Oedipus goebeli* in a rotten log at about 8,700 feet on the Volcan Agua, at the opposite end of the range from Tajumulco. This specimen, collected by Mr. Daniel Clark and myself, is supplemented by another from the same volcano collected by Mr. F. X. Williams at 9,000 feet. My brother reached the lower part of the cloud-forest, between six and seven thousand feet, on the Volcan Atitlan, and there found *Oedipus franklini* and *O. engelhardti* in great abundance, just as exclusively confined to the bromeliads as they are on Tajumulco. *Oedipus franklini* has been traced to the Volcan Pacaya, where a specimen was collected from a bromeliad at 7,700 feet by Mr.

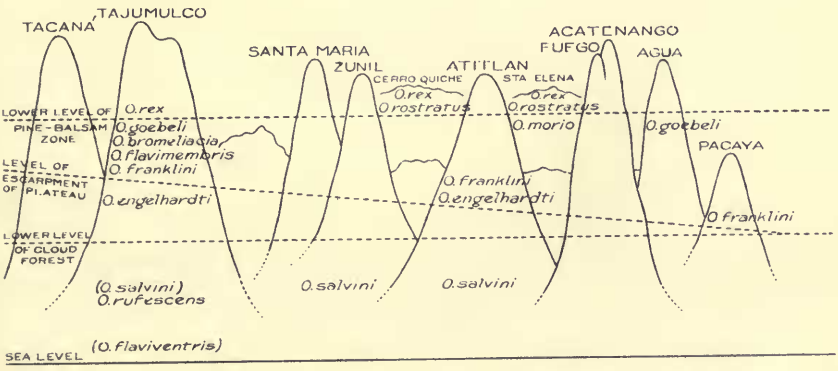

FIG. 16. Distribution of the species of *Oedipus* on the Guatemalan chain of volcanoes (see text).

Williams. The blanks on the accompanying diagram greatly exceed the positive information, but it is clear that a majority of the species may be expected on all of the volcanoes, and there is no suggestion of endemism on any single volcano. Since the level of the escarpment of the plateau, ranging from about 5,000 feet between Pacaya and Agua to 8,300 feet in San Marcos, is everywhere above the lower limit of the cloud-forest, there is no difficulty in explaining this great horizontal range of its species. This continuity is now somewhat broken by the tremendous gorges cut back into the highland by the rivers flowing into the Pacific; but these breaks are obviously relatively recent. The lowland species have a continuous habitat on the very uniform Pacific coastal plain, which extends from Salvador through Guatemala into Chiapas. Only *Oedipus rex* and *Oedipus goebeli* appear to have a discontinuous distribution, being

strictly confined to altitudes above the level of the plateau. This discontinuity may well be post-glacial, as the lower limits of the temperate zone must have been at a much lower level in glacial times; but it is instructive as to the rate of species formation in this genus that they have not become differentiated in the subsequent period of time.

Only one of the Tajumulco species, *rex*, is found also on the central highland, to which *rostratus* and *morio* appear to be confined. The wide range of *rufescens* in the tropical zone on both the Caribbean and Pacific slopes seems readily explicable in view of its range into Mexico, where the Pacific and Atlantic lowlands are joined at the Isthmus of Tehuantepec. *Oedipus helmrichi* appears to be a distinct, small species confined to the bromeliad habitat at high altitudes in Alta Verapaz. *Oedipus mülleri* and *O. mexicanus* on the Caribbean side are probably directly allied to *platydactylus*, as are *flaviventris* and *salvinii* on the Pacific slopes.

Great additions to our knowledge of the distribution of this extraordinarily diversified genus may be expected from further collecting along the border between Guatemala and Honduras, and in the wholly unexplored Sierra de Minas. The great combined bulk of Acatenango and Fuego, from whose subtropical zones not a single salamander is yet known, affords the most promising point of attack for the verification and extension of the data derived from the series herein described from Tajumulco.

Oedipus mexicanus (Duméril and Bibron).

Bolitoglossa mexicana (part) Duméril and Bibron, Exp. Gen., 9, p. 93, atlas, pl. 104, fig. 1, 1854.

Spelerpes dofleini Werner, Abh. Bayer. Akad. Wiss., 22, p. 352, 1903.

The specimen figured by Duméril and Bibron as fig. 1, pl. 104, apparently came from Dolores, Peten, from the collections of M. Morelet. Whether it is correct to employ the name *mexicanus* for this form, which ranges from Peten to Spanish Honduras, is open to question. The original *mexicanus* was based primarily on specimens of *Oedipus bellii*, as may be seen from the diagnosis of the species, secondarily on specimens of a different species from Vera Cruz, and only as a late addition to the manuscript on the Peten specimen. I do not, however, find any unambiguous reference of *mexicanus* to the synonymy of *bellii* or to the restricted uniform-backed *platydactylus* of Vera Cruz. The extremely heterogeneous "*mexicanus*," may now be restricted to the spotted and striped Peten form.

This avoids the question (which I am unable to settle) as to whether Werner's *dofleini* belongs here, and also the alternative possibility of adding still another name to this genus. The Guatemalan specimens examined are three from Peten, collected by Mr. Harry Malleis, and now in the collection of the Museum of Zoology of the University of Michigan. These are much darkened by formalin preservation, but they unquestionably are the same form as Duméril and Bibron's Peten specimens, and as the British Honduras and Honduran specimens described by Dunn. *Spelerpes dofleini* Werner from Alta Verapaz may be placed here provisionally, rather than in the synonymy of *yucatanus*, from which it is geographically remote, or of *mülleri*, which is from the same type locality, but which it does not resemble.

Until more comprehensive material is available, it seems futile to attempt the assortment of the forms allied to *platydactylus* into groups of subspecies, although I am in complete agreement with Dunn that this will ultimately be necessary.

Oedipus salvinii Gray.

Oedipus salvinii Gray, Ann. Mag. Nat. Hist., (4), 2, p. 297, 1868.
Spelerpes attitlanensis Brocchi, Miss. Sci. Mex., p. 118, pl. 19, figs. 3–4, 1882.
Spelerpes variegatus Günther, Biologia Centr.-Amer., pl. 75, fig. B, 1902.

I was able to examine the types of both *salvinii* and *attitlanensis* in 1932 and am convinced that Brocchi's species is exactly the same as Gray's. The type of *salvinii*, though faded, clearly has a pigmented belly, and lacks altogether the sharply marked lateroventral line, which is shown in Brocchi's figures of what he supposed to be *salvinii*, and which is shown exactly like Brocchi's figures in specimens of *Oedipus* referred to *salvinii* and *attitlanensis* by Dunn in 1926. Brocchi's figures and description of *attitlanensis* on the other hand, agree excellently with the type of *salvinii*.

Mr. Joseph R. Slevin collected a series of this species in 1926 at the Finca El Cipres in the coffee zone at the base of the Volcan Zunil. These agree exactly with the original *salvinii* in their pigmented ventral surfaces, bold dorsal pattern, and fully webbed toes. The series exhibits a characteristic type of pattern variation from the largely orange back with a median chocolate stripe about one-third the width of the dorsal area, in six specimens, through a type in which the orange ground color is reduced to a dorsolateral stripe, more or less broken into spots, in three specimens, to a single specimen in which this orange color is reduced to a few elongate spots

anteriorly and a single one at the base of the tail. Günther figures a specimen of this species with reduced amount of orange in the pattern as a variant of his comprehensive *Spelerpes variegatus*. The larger specimens in this series measure from 98 to 121 mm., with the tail about equal to the body-length. One specimen from Posadas, Volcan Zunil, measures 171, with a tail-length of 91, thus approaching in size *Oedipus flaviventris*. *Oedipus salvinii* and *O. flaviventris* are clearly very closely allied forms whose mutual relations afford an interesting problem for studies in the field.

A specimen which arrived in Chicago alive in bananas, reached the home of Mr. and Mrs. Herman Gesswein, who presented it to Field Museum. In this specimen, an adult male, No. 22863, the colors in life are: general dorsal color black, with faint tinge of reddish brown in certain lights; sides a little lighter, shading gradually to Russet on the mid-ventral area; limbs between Vandyke Brown and black; dorsolateral band Ochraceous Buff, with very narrow lighter yellow border, but without silvery outline.

Oedipus flaviventris sp. nov.

Spelerpes salvinii Brocchi (nec Gray), Miss. Sci. Mexique, p. 117, pl. 18, figs. 3–4, 1882.

Oedipus salvinii Dunn (part), Plethodontidae, p. 405, 1926.

Oedipus attitlanensis Dunn (nec Brocchi), Plethodontidae, p. 408, 1926.

Type from Chicharras, Chiapas. No. 46922 United States National Museum. Adult female. Collected February 7, 1896, by E. W. Nelson and E. A. Goldman.

Diagnosis.—A large, robust species, with digits fully webbed, long series of vomerine teeth, ventral surfaces unpigmented, dark lateral band with a sharply defined border both above and below, where it meets the light ventral and dorsal areas.

Description of type.—Body robust, tail shorter than head and body; length of head three and three-fourths times in length to vent; width of head six and three-fourths times in the same measurement.

Costal grooves thirteen, four costal folds between the appressed toes; fingers and toes completely enclosed in web; tail sharply constricted at base; vomerine teeth about seventeen on each side, extending beyond the internal nares laterally; maxilla toothed as far as middle of eyes.

Light yellow above and below, with sharply set off dark chocolate brown lateral bands from eye to base of tail; legs marked with brown;

FIG. 17. From left to right: *Oedipus salvinii*, one with broad and one with narrow dorsolateral bands; *O. goebeli*, dorsal and ventral views; *O. rex*, dorsolateral and ventral views; *O. rostratus;* and *O. flavimembris*.

upper border of lateral band very irregular; a mid-dorsal band of the same color as the sides, beginning between the eyes and extending to the base of the tail; a single dark spot on tip of snout; tail immaculate beneath, with irregular spots and flecks of the dark color above on a light ground.

Length 188, head to gular fold 20, tail 93.

Notes on paratypes.—A second specimen from Chicharras, U. S. National Museum No. 46923, and No. 30305 from Tehuantepec, belong clearly to this form. In these specimens the amount of dark color on the back varies from a minimum in No. 46923 to a maximum in No. 46922, while No. 30305 is almost exactly intermediate in this respect. In the type specimen, the yellow dorsal ground color is reduced to a narrow band between the dark of back and sides. A specimen in Field Museum, No. 21078, obtained through Mr. Gordon Pearsall from the basement of a fruit dealer in Chicago, corresponds exactly in dorsal coloration with the specimens of *salvinii* in which the orange color is reduced to dorsolateral spots; but this specimen has clear yellow ventral surfaces, sharply distinguished from the dark brown sides. This specimen measures 141 mm. in length, of which the tail forms 78 mm. The general color above is Carib Brown, becoming lighter on the sides, to Chestnut Brown; the upper surfaces of the limbs are colored like the back; the chin and lower surfaces of the limbs are Ochraceous Tawny; the remaining ventral parts are Ochraceous Buff tending toward Ochraceous Orange; the light dorsolateral spots are Pale Ochraceous Buff.

The origin of this specimen from the Pacific side of Guatemala is made extremely probable by its correspondence with the Mexican specimens above described and by the fact that large shipments of bananas are now made by train from the Pacific coastal plain of Guatemala to Puerto Barrios, where they are transferred to the New York and New Orleans steamers. The two specimens from Chiapas were referred to *attitlanensis* by Dunn, and the Tehuantepec specimen to *salvinii;* but Brocchi's species had a black venter, as has the type of *salvinii.* The specimens from the Isthmus of Tehuantepec figured by Brocchi as *salvinii* clearly belong to the yellow-bellied form. It seems likely that *flaviventris* is the larger lowland representative of *salvinii* of the coffee zone.

Oedipus mülleri (Brocchi).

Spelerpes mülleri Brocchi, Miss. Sci. Mex., p. 116, pl. 20, figs. 3–5, 1882.
Spelerpes variegatus Werner (nec Gray), Abh. Bayer. Akad., **22**, p. 352, 1903.

The specimens recorded by Werner in the Munich Museum, collected by Karl Sapper in Alta Verapaz, correspond exactly with Brocchi's description; the median orange band on the back, of varying width, occasionally broken into spots, is characteristic. A single specimen, Field Museum No. 20733, was collected by myself at Samac, near Coban, Alta Verapaz. Although unfortunately only a fragment, having been cut in two with the ax in the course of felling a tree for the examination of bromeliads, this specimen agrees excellently with the others known. Brocchi's figure 3, from the Rio Polochic, does not represent this typical coloration, and I believe it to be referable to *Oedipus mexicanus* as herein defined. His variety described from the Rio de la Pasion, Alta Verapaz, therefore from low altitude, also doubtless belongs to *mexicanus*. Additional specimens of all the species with fully webbed toes are much to be desired for the elucidation of their relations and distribution.

Oedipus rufescens Cope.

Oedipus rufescens Cope, Proc. Acad. Nat. Sci. Phila., **1869**, p. 104, 1869; Dunn, Plethodontidae, p. 418, fig. 79, 1926.

This species is described by Dunn from specimens from Trece Aguas, a plantation on the Rio Cahabon, toward the Atlantic lowland of Alta Verapaz. Sixteen specimens collected by myself at Samac and Coban, Field Museum Nos. 20734–35, agree excellently with these; and twenty-one specimens from El Porvenir, Nos. 20397–99, 20330, 20712–13, 20748–49, and 20760, on the Pacific slope at the base of Tajumulco, are indistinguishable from those from the Atlantic drainage. Two specimens from Escobas, Izabal, little above sea level, Nos. 20683 and 20740, are a little larger than any of the others. At Samac one specimen was obtained from a bromeliad, while all the rest came from beneath the leaf sheaths of bananas, as was the case at El Porvenir. The specimens from Escobas, one of which was obtained by Daniel Clark, were both found in bromeliads. These specimens all agree in their fully webbed toes and fingers, of which the third makes a sharp point in the general outline, and the absence of maxillary teeth. The coloration is highly variable, a striatulate dorsal marking usually visible when the general color is sufficiently light to bring out any markings. The dorsal color in life of a specimen from El Porvenir is Vinaceous Fawn; a darker specimen has Kaiser Brown dorsolateral stripes on a similar ground color. I believe this species to be a normal bromeliad inhabitant which has become more abundant beneath the leaf

sheaths of bananas wherever these are more available. It is reported by Slevin (in litt.) from Finca El Cipres in the coffee zone on the Volcan Zunil, also from banana leaf sheaths.

The availability of the name *rufescens* for this lowland form requires a note. The type was said to have come from the alpine zone on Orizaba; and I know of no other species ranging from sea level to this zone. Unless some form to which the name is applicable can be found on Orizaba at high altitude, it is preferable to regard the stated origin of the type as erroneous. The absence of maxillary teeth seems to afford an excellent distinctive character. The second locality given by Sumichrast, Santa Efigenia in Oaxaca, and its bromeliad habitat, are in agreement with its distribution and habitat in Guatemala.

Oedipus helmrichi sp. nov.

Type from mountains above Finca Samac, west of Coban, Alta Verapaz, Guatemala, at 5,000 feet altitude. No. 21063 Field Museum of Natural History. Adult male. Collected March 31, 1934, by Daniel Clark.

Diagnosis.—An *Oedipus* of normal body form, tail about equal to length of head and body, maxilla toothed, limbs well developed, nostrils not enlarged, one terminal phalanx free from web, general color dark, under side of tail pale yellow with scattered black spots.

Description of type.—Body of normal form, limbs well developed, tail about half the total length; the length of head to gular fold 3.7 times in the length of body, the width of head a little more than five times in the same length; head oval as seen from above, snout truncate.

Costal grooves thirteen, the appressed toes meeting at the sides; fingers and toes broadly webbed, about one phalanx of each digit free from web; inner digit well developed; digits rounded at tip; an obscure groove from eye to vertical groove just behind angle of jaw; nostrils not enlarged; tail sharply constricted at base; vomerine teeth about six, in arched rows, extending as far as the choanae and closely approximated on the mid-line; a deep groove from the choanae extending posterolaterally; maxillary teeth present; a slight dermal dorsolateral ridge.

General color dark brown above and on sides and belly; upper surface of tail with obscure light markings, its lower surface clear pale yellow, with scattered small black spots; chin and belly with a few small light dots.

FIG. 18. From left to right: *Oedipus rufescens*, two specimens from El Porvenir; *O. helmrichi*, type; *O. bromeliacia*, two specimens; and *O. engelhardti*, two specimens.

Length 75, tail 38, length of head 10, width of head 6.9.

Notes on paratypes.—Fifteen specimens, Field Museum No. 20727, were collected by Mr. Clark from bromeliads in the forest on the mountain behind Samac. The type is the largest of these. In the paratypes the coloration is highly variable, and may be pale both above and below; even in the most light-colored specimen, however, the absence of black pigment on the under side of the tail is conspicuous.

Remarks.—But for the presence of maxillary teeth, I would regard this species as a direct offshoot of *rufescens*, which is abundant in a similar habitat a thousand feet below the level at which *helmrichi* is found. *O. helmrichi* has distinctly shorter webs than *rufescens*, and is evidently a fully distinct species; it is a small bromeliad inhabitant which has not developed enlarged nostrils. The species is named for Mr. Gustav Helmrich, of the Finca Samac; the cordial hospitality of Mr. and Mrs. Helmrich is one of the most pleasant recollections of our Guatemalan journey.

Oedipus morio Cope.

Oedipus morio Cope, Proc. Acad. Nat. Sci. Phila., **1869**, p. 103, 1869.

Spelerpes bocourti Brocchi, Miss. Sci. Mexique, pt. 3, sec. 12, p. 11, pl. 18, fig. 2, 1882.

The proper allocation of the name *morio* has been one of the principal difficulties in reaching a satisfactory conclusion as to the number and distribution of the Guatemalan species of the genus. The type is presumably lost; and in Dunn's monographic treatment of the family Plethodontidae *morio* was applied to the species from the Sierra Merendon subsequently described by myself as *Oedipus dunni*. The discovery of a highland species to which the name is correctly applied is due to the visit of Mr. Joseph R. Slevin to Santa Elena and Chichivac, above Tecpan, where he collected large series of three species of salamanders. Of these the one from Chichivac, at about 8,600 feet altitude, in the oak and pine zone, and definitely below the cypress zone at Santa Elena, corresponds very well with the original description of *morio*, especially in the amount of webbing of the digits, the short tail, and the characteristic white spotting of sides and limbs. On my own visit to the same collecting stations in February, 1934, although large numbers of *Oedipus rostratus* and *O. rex* were to be found in the cypress zone above 9,000 feet, only a single specimen of *morio* (No. 20241) was found at Chichivac, at 8,700 feet; this however, corresponds exactly with the large series in

the California Academy of Sciences, which Mr. Slevin collected at the lower station in October. He found the species almost exclusively beneath the bark and in the rotten wood of old oak stumps. The species described by Brocchi as *Spelerpes bocourti* from the pine forests of the heights of Totonicapan is certainly the same as *morio*. The illustration of *bocourti* is too vividly colored, but shows the stocky body and short tail. The white flecks characteristic of *morio* are occasionally confluent into larger spots and markings or a lateral stripe and may be tinged with yellow. The oak-pine zone is well developed at Totonicapan, and continuous with that of the Sierra Santa Elena. *Oedipus morio*, in fact, is probably the common species of the plateau.

Oedipus rostratus Brocchi.

Oedipus rostratus Brocchi, Miss. Sci. Mexique, pt. 3, sec. 2, p. 112, 1882.

Specimens of this species collected at Santa Elena by C. M. Barber in 1906 were correctly named by Dunn in his monograph of the family, and both Slevin and I have subsequently collected large numbers of specimens at the same locality. There are 215 Field Museum specimens catalogued as Nos. 3487(4), 19444, 20234(122), 20240(24), 20282–85, and 20286(56). In addition to these I have examined three specimens collected by Mr. F. X. Williams on Cerro Quiché, which is on the heights above Totonicapan, so they may be regarded definitely as topotypes. Brocchi's description mentions the proportionately longer tail (as compared with *bocourti* or *morio*), and describes the coloration as orange above, with the exception of the top of the head, "blue lilac" on the sides and head, limbs clear yellow, and ventral surfaces yellowish white. This is far from a satisfactory description; but it can be matched in occasional specimens. In the large series now available the most frequent pattern is a pair of light yellowish dorsolateral bands, whose lateral margin tends to be sharply defined by the dark color (a very dark reddish brown), of the sides, while their inner margins are diffuse where they meet the brownish mid-dorsal band of varying width. The sharp dorsolateral line begins on the canthus rostralis. The darker mid-dorsal band may be entirely wanting except for the top of the head, in which case the coloration corresponds to Brocchi's description. This appears to be the normal juvenile pattern; in the smallest specimen available, 28 mm. long, the whole dorsal area including the upper side of head and tail is yellow, with the slight darker markings on the head, and the limbs are bright clear yellow.

Formalin specimens are much darkened in preservation and may have the ventral surfaces very dark.

The most obvious ally of this species is *Oedipus engelhardti*, from the bromeliad habitat in the cloud-forest on the south slopes of Tajumulco and Atitlan, in which the digits are distinctly more webbed. In spite of the juxtaposition of *rostratus* and *morio* at Tecpan, there seem to be no transitional specimens. The two are sharply distinguished by coloration and by relative length of tail, which in *morio* ranges from 0.47 to 0.50, average 0.48, in males; 0.45 to 0.49, average 0.47, in females; while in *rostratus* males range in this character from 0.51 to 0.57, average 0.54; and in females from 0.49 to 0.52, average 0.51.

The two species at Santa Elena, *Oedipus rex* and *O. rostratus*, were found in the same habitat and frequently under the same log or stone. There was perhaps a slight preponderance of *rex* in the cypress forest and of *rostratus* under stones along the road.

On February 7, 1934, I discovered a female coiled about an egg mass, situated in an excavation in the earth beneath a large stone on the roadside at 9,500 feet altitude. There are thirty-six eggs in the rounded mass, and the individual egg with its gelatinous envelope measures about 4 mm. in diameter. The egg proper, with embryo well advanced, measures 3.6 mm.

The only reference to the breeding habits of the genus *Oedipus* appears to be that of Posada (Estudios Scientificos, Medellin, 1909, p. 125, quoted by Dunn, 1926, p. 393), who states that *Oedipus adspersus* of Colombia is ovoviviparous. This, together with anatomical examination of the oviducts, appears to be the basis for Noble's general statement (1927, p. 57) that *Oedipus* gives birth to living young; this statement must be restricted to *Oedipus adspersus* until other species are investigated.

Oedipus engelhardti sp. nov.

Type from Volcan Atitlan, 7,000 feet above Olas de Moca, Solola, Guatemala. No. 21065 Field Museum of Natural History. Adult female. Collected March 9, 1934, by F. J. W. Schmidt.

Diagnosis.—An *Oedipus* of normal body form and medium size, tail a little longer than body, nostrils not enlarged, one phalanx of each of the outer digits free from web, ten vomerine teeth on each side, coloration uniform or with a dorsolateral light band.

Description of type.—Body of normal form, limbs well developed, tail as long as the body; head to gular fold four times in length of

body, width six and a fraction times in the same distance; head oval as seen from above, little wider than the neck, not at all angulate in outline.

Costal grooves thirteen, three folds between the appressed toes; fingers and toes webbed, one phalanx of all except the inner digits free; order of length of fingers 3–4–2–1, of toes 3–4–2–5–1; a faint groove from the posterior corner of the eye extends to a vertical groove just behind the angle of the jaw; nostrils not enlarged; tail constricted at base; vomerine teeth about ten on each side, meeting on mid-line, not extending beyond the choanae; maxillae toothed; a faint dermal dorsolateral fold.

Dark gray above, lighter on the sides, pale yellow beneath, without a sharp dividing line.

Length 95; tail 47; head to gular fold 12; width of head 7.5; arm 11; leg 12.

Notes on paratypes.—One hundred and nine paratypes are available for comparison with the type, ninety-four from the type locality, collected by my brother, and fifteen from Volcan Tajumulco, between 5,500 and 6,500 feet, which we collected together. The ten largest males range from 83 to 92 mm. in length, and the tail averages 0.53 of the total. The ten largest females range from 79 to 95 mm., and the tail from 0.46 to 0.54 of the total, averaging 0.51. In the great majority of specimens from the type locality the dorsal coloration is uniform gray; a few adult specimens and a few more juveniles have a sharply defined light dorsal area, extending to a dorsolateral line, or have a similarly defined pair of broad light dorsolateral bands. The banded coloration is more frequent in the Tajumulco series.

Remarks.—Although only fifteen specimens were obtained on Tajumulco, the altitudinal distribution of this species seems to be extremely well defined. None at all were to be found at 5,000 feet, and only once, at 6,500 feet, were specimens found with the abundant *O. bromeliacia.* In the lower cloud-forest zone this species is associated on both Tajumulco and Atitlan with the larger *Oedipus franklini.*

This species, in its banded color pattern, strongly resembles *Oedipus rostratus* of the Guatemalan highland. It is adequately distinguished from *rostratus* by its constantly greater extent of web.

I take pleasure in associating the name Engelhardt with this species. We were repeatedly entertained at Olas de Moca, which has long been known in scientific literature from the visits of other scientific parties.

Oedipus flavimembris sp. nov.

Type from Volcan Tajumulco, at 7,200 feet, on the trail above El Porvenir, San Marcos, Guatemala. No. 20381 Field Museum of Natural History. Adult female. Collected March 3, 1934, by Karl P. Schmidt.

Diagnosis.—An *Oedipus* of large size, robust in body form, with tail shorter than body; nostrils not enlarged; digits webbed except for the terminal phalanges; uniform tawny gray in color above, with bright yellow limbs and dark feet.

Description of type.—Body stout, much longer than tail; head to gular fold contained about four times in length from snout to anus; width of head five and one-half times in the same measurement; head oval as seen from above, snout scarcely truncate.

Costal grooves thirteen, two costal folds between appressed toes; fingers and toes broadly webbed, the terminal phalanx free in all except the inner digit; order of length of fingers 3–2–4, and of toes 3–4–5–2–1; a faint groove from the posterior corner of the eye meets a more distinct one which descends vertically just behind the angles of the jaw, and is continued as a faint groove across the throat; nostrils not enlarged; tail strongly constricted at the base, vomerine teeth twelve on each side, in arched series narrowly separated on the mid-line, extending laterally beyond the choanae.

General color of back in life uniform Hair Brown, lighter on sides and venter, lightest on chin, limbs Colonial Buff, feet dark gray above and below, and an obscure dark line down middle of belly. The coloration is little changed in alcoholic specimens.

Length 99, tail 43, head to gular fold 14.3, width of head 10.1, arm 14, leg 16.

Notes on paratypes.—Ten specimens, Field Museum Nos. 20296, 20321–23, and 20393, all collected beneath stones or logs on the trail, and all collected between 7,000 feet and 7,500 feet, are available for comparison. The combination of tawny body, bright yellow limbs, and dark feet is extremely uniform in this series. The costal grooves are uniformly thirteen, the folds between appressed toes one or two; the largest specimen, a female, measures 115, tail 55, the smallest 50, tail 20.

Remarks.—This species appears to be most nearly allied to robust forms like *bellii* and *schmidti*, but differs from them conspicuously in coloration, dentition, and proportions. It may be compared also with *Oedipus morio* of the Guatemala highland, which has shorter

webs and is a smaller species, but which frequently has yellow-spotted limbs, and thus exhibits an approach to the unique coloration of *flavimembris*.

Oedipus franklini sp. nov.

Type from Volcan Tajumulco, at 5,600 feet altitude, on the trail above El Porvenir, San Marcos, Guatemala. No. 21061 Field Museum of Natural History. Adult male. Collected March 1, 1934, by Karl P. Schmidt.

Diagnosis.—An *Oedipus* of normal body form, large size, the tail a little more than half the total length, limbs well developed; nostrils not enlarged; two terminal phalanges free from web; black beneath, dorsal light area normally sharply defined at a dorsolateral line, with a very variable amount of dark markings.

Description of type.—Body of normal form, tail a little longer than body; head to gular fold three and one-half times in the length to the anus; width of head five and one-half times in the same measurement; head angular as seen from above; snout sharply truncate.

Costal grooves thirteen, the appressed toes meeting at the sides; fingers and toes webbed at base, two phalanges of all except inner digit free; inner digit well developed; digits all sharply truncate at tip, with a rounded pad beneath; order of length of fingers 3–4–2–1, and of toes 3–4–5–2–1, a distinct groove from eye to a vertical groove behind the angle of the jaw; nostrils not enlarged, tail sharply constricted at base; vomerine teeth about fifteen on each side, in long uniformly curved rows nearly meeting on the mid-line and extending beyond the choanae; maxillary teeth present; a dermal dorsolateral ridge crosses the costal folds and grooves, the grooves in consequence very conspicuous.

Black beneath and on sides, meeting the light dorsal area at a sharply defined dorsolateral line; the light area with irregular large spots; tail with irregular light spots, like the dorsal ground color.

Length 115, tail 63, head to gular fold 15.1, width of head 9.5.

Notes on paratypes.—Material available for comparison consists of seventeen specimens from the Volcan Tajumulco between 5,500 and 8,000 feet altitude, Nos. 20318–20, 20388–92, 20650, 20655–56, 20691–92; and eight from the Volcan Atitlan, above Olas de Moca at about 7,000 feet altitude, with the addition of a specimen collected by Mr. F. X. Williams on the Volcan Pacaya for the California Academy of Sciences. The largest Tajumulco specimen, a male,

FIG. 19. Variation in *Oedipus franklini*.

measures 129 mm. and has a reproduced tail, the body being 66 mm. in length. Female specimens are more robust in body and have shorter tails, about equaling the body length. Specimens from the Volcan Atitlan, all collected by F. J. W. Schmidt, are a little larger than the average of the Tajumulco specimens. The smallest specimen found measures only 29 mm. and is entirely black.

The light ground color of the back in life is Buffy Citrine, with scattered black spots, with a narrow Wax Yellow outline. The black of the sides is similarly outlined above. In another specimen, the light ground color is olive yellow. The yellow margining of the spots tends to disappear in alcoholic specimens.

Remarks.—The variable dorsal pattern and large size of this species recall *Oedipus flaviventris*, which has a yellow belly and fully webbed toes, and the latter character also distinguishes *O. salvinii* from the present form. All of the specimens were found in bromeliads, associated with *Oedipus engelhardti* at the lower levels and with *bromeliacia* at higher altitudes. The black ventral surface immediately distinguishes juvenile specimens from *O. engelhardti*. This species is named for my brother, Franklin James White Schmidt.

Oedipus bromeliacia sp. nov.

Type from Volcan Tajumulco, at 8,000 feet altitude, on the trail above El Porvenir, San Marcos, Guatemala. No. 21062 Field Museum of Natural History. Adult male. Collected February 22, 1934, by Karl P. Schmidt.

Diagnosis.—Body form normal; size small; nostrils enlarged; toes free; two costal folds between appressed toes; internasal space equal to twice the diameter of a nostril.

Description of type.—Body form normal, tail longer than head and body, limbs well developed; length of head to gular fold contained four times in length from snout to anus; width of head nearly six times in the same distance; head viewed from above sharply emarginate between eye and nostril; snout truncate; upper jaw strongly projecting beyond lower.

Costal grooves thirteen, two folds between the appressed toes; two phalanges of fingers and toes free from web, their tips with a disk-like pad beneath; first phalanx vestigial, third longest, remaining phalanges subequal on both hand and foot; vomerine teeth six on each side; maxillary teeth present; a pair of glands on the parietal region forming a V; tail constricted at base.

General color very dark brown; a light pink band from eye to eye, and snout anterior to this band lightly mottled; traces of a red scapular marking, and a conspicuous reddish marking above the base of the tail; belly strongly pigmented, chin and throat spotted with lighter color; under side of tail lighter than belly.

Length 73, head to gular fold 7.7, width of head 5.3, tail 42.

Notes on paratypes.—Fifty-seven specimens, Field Museum Nos. 20291, 20294, 20324–26, 20382, 20657, 20693, 20695–7, and 20700, all collected between 6,000 and 9,000 feet on the south slope of Tajumulco, and all, like the type, found in bromeliads, form the paratype series. The largest male specimen measures 76 mm., the largest female 75 mm. The smallest specimen measures 32 mm., and the nostrils are distinctly enlarged in the smallest specimens. The distribution in size groups exhibits a fairly distinct division into small and large.

Size (mm.)	Number of specimens	Size (mm.)	Number of specimens	Size (mm.)	Number of specimens
32–40	3	51–55	6	65–70	8
41–45	8	56–60	11	71–75	4
46–50	3	61–65	11	76–80	1

The tail is slightly longer in males, averaging 0.56 of the total, and ranging from 0.55 to 0.59, in the ten largest specimens; in females it ranges from 0.49 to 0.56, averaging 0.53.

The coloration is extremely variable, though a fundamental uniformity of pattern is discernible. The reddish markings at the base of the tail and the light line from eye to eye prove to be very constant. The former may be confluent with more extensive light markings of the back, usually pink, which include the whole dorsal surface of body and tail in four specimens. In one of these the dorsal color (in alcohol) is dark red, separated at a sharp dorsolateral line from the dark sides. The line between the eyes may be confluent with a light area covering the whole upper side of the snout anterior to it (five specimens). The dark color of the belly is usual but not invariable, as the belly is light in occasional specimens in either sex and in both small and large individuals. There is sometimes a narrow silvery lateroventral line. In one specimen narrow yellowish dorsolateral bands extend from the eyes to the base of the tail. Irregular wavy dark markings are present in all specimens in which the dorsal ground color is light gray.

The distribution in altitude falls between 6,500 and 9,000 feet; examination of some hundreds of bromeliads at 5,000 feet, 5,600

feet, and 10,400 feet failed to produce a single specimen. The maximum of abundance falls clearly between 7,500 and 8,500 feet.

Remarks.—This species is clearly most closely allied to *Oedipus nasalis* from the mountain range extending toward the northern coast on the boundary between Guatemala and Honduras; its nostrils are distinctly smaller than in *nasalis* and the snout more projecting. It is interesting to add a fifth species to the series with enlarged nostrils.

Oedipus goebeli sp. nov.

Type from Volcan Tajumulco, at 8,000 feet altitude, on the trail above El Porvenir, San Marcos, Guatemala. No. 21064 Field Museum of Natural History. Adult female. Collected February 15, 1934, by Karl P. Schmidt.

Diagnosis.—An *Oedipus* of normal body form and medium size; tail about as long as head and body; limbs well developed; nostrils not enlarged; fingers and toes free from web; dark beneath, the chin and throat to gular fold lighter and the under side of the tail marbled with yellow, general color above dark, with an obscure lighter mid-dorsal band sometimes distinguishable.

Description of type.—Body of normal form, tail slightly longer than head and body, the head to gular fold contained four times in the length from snout to anus, and its breadth six times; head oval in outline as seen from above, snout rounded.

Costal grooves thirteen, one costal fold between the appressed toes; digits webbed at base, more than two phalanges free; first finger and toe well developed; digits rounded at tips, with a rounded pad beneath; a distinct groove from eye to gular fold, crossing the vertical groove behind the angle of the jaw, which connects with its fellow across the chin; nostrils not enlarged; tail constricted at base; vomerine teeth in slightly arched transverse series, about nine teeth in each row, extending beyond the choanae laterally; maxillary teeth present; no trace of a dorsolateral fold.

Dark brown above, with a reddish tinge on the back between the costal folds, darker on the sides and belly; the chin and throat to the gular fold yellowish; under side of tail mottled with yellow; inner faces of feet lighter, pads at tips of digits yellow.

Length 123, tail 64, head to gular fold 14.1, width of head 10, arm 15, leg 17.

Notes on paratypes.—Field Museum Nos. 20295, 20298(4), 20299(11), 20301(15), and 20694, were collected on Volcan Tajumulco,

between 8,000 and 10,400 feet. No. 20406 comes from 8,500 feet on Volcan Agua. A second specimen from Agua, from about the same altitude, was collected by Mr. F. X. Williams for the California Academy of Sciences and was loaned for examination through the courtesy of Mr. J. R. Slevin. In a small proportion of these specimens, the reddish suffusion of the back is much increased. In every case, however, even in specimens only 32 mm. in length, the species can be recognized at once by the contrast between the black belly and the lighter throat and under side of the tail.

The length of tail varies only from 0.48 to 0.52 of the total in both sexes. The five largest females range in length from 110 to 123 mm., and the five largest males from 94 to 117 mm. In juvenile specimens the tail is much shorter; the smallest specimen measures 32 mm., with tail 13 mm. The specimens from Volcan Agua agree in detail with those from Tajumulco.

Remarks.—This species agrees in its greatly reduced webs with *Oedipus rex,* and was at first difficult to distinguish from that species, the two being found in the same logs in the balsam zone on Tajumulco. No specimens corresponding to *goebeli* were found at Santa Elena, where many specimens of *rex* had been obtained. With further collecting on Tajumulco it was learned that *goebeli* was in fact much more abundant in rotten hardwood logs burrowed by passalid beetles in the upper levels of the cloud forest, while no *rex* were to be found in this habitat; moreover, *rex* is abundant in the pine forest above the balsam zone, and no *goebeli* are found there. *O. rex,* in addition to its smaller size, shorter limbs, and longer tail, always has the under side of the tail dark; while *goebeli* never has the upper side of the tail lightened, as is frequent in *rex,* except as part of the general suffusion of the back with red.

This species apparently agrees somewhat more closely with *Oedipus cephalicus* of the Mexican escarpment than with *rex.* It differs from *cephalicus* in its shorter vomerine tooth rows, and has a different style of coloration, in which, however, the reddish dorsal band compares with the same variant in *goebeli; O. goebeli* has distinctly longer limbs than either *cephalicus* or *rex.* The species is named for Dr. H. Goebel, at whose invitation we went to El Porvenir.

A single specimen, No. 20694, was found on the trail at night by F. J. W. Schmidt. One specimen was found in the outer dry leaves of the lowermost bromeliad on a nearly horizontal log. Otherwise all specimens came from rotten logs.

Oedipus rex Dunn.

Oedipus rex Dunn, Proc. Biol. Soc. Wash., 34, p. 143, 1921; Plethodontidae, p. 366, fig. 61, 1926.

The type and ten paratypes of this species were collected by C. M. Barber at Santa Elena in 1905. The collections of the Mandel Guatemala Expedition include 187 specimens, of which Nos. 20235, 20239, and 20281 (133 specimens) are from the type locality, and Nos. 20300, 20305, 20317, 20688, 20747, 20754, and 21066–7 (54 specimens) are from the temperate zone on the Volcan Tajumulco.

Oedipus rex was the most abundant salamander at 10,400 feet on Tajumulco, where it was found in crevices in rotten pine and balsam logs, associated with a small number of *Oedipus goebeli*. It was not found below 10,000 feet; I was able to trace it to 11,000 feet, and twenty-two specimens loaned for examination by the California Academy of Sciences were collected by Mr. F. X. Williams between 11,700 and 12,700 feet on the same mountain. This collector obtained a single specimen on Cerro Quiché on the central highland at 11,000 feet, where it was associated with *O. rostratus*, as it is at Santa Elena.

This species is most clearly distinguished from *goebeli* by its shorter limbs, which leave two to four folds between the appressed toes; smaller size, average adult length about 90 mm.; and the distinct difference in coloration, which is described above. The ten largest specimens range from 85 to 99 mm. in length, as compared with 108 to 123 in *goebeli*.

Oedipus elongatus sp. nov.

Type from Escobas, the site of the water supply for Puerto Barrios, Izabal, Guatemala. No. 20059 Field Museum of Natural History. Adult male. Collected December 3, 1933, by Daniel Clark.

Diagnosis.—A worm-like *Oedipus* with reduced limbs; toes fully webbed; 17 costal grooves; no basal constriction of tail; and eye shorter than snout.

Description of type.—Body and tail elongate, the tip of the tail missing; length of head contained five and a half times in that of body, width of head a little more than eight times; snout truncated as seen from above, strongly flattened, distinctly longer than the eye; upper jaw strongly projecting beyond the lower; limbs weak.

Costal grooves seventeen, eight costal folds between the tips of the appressed toes; fingers and toes completely webbed, the web extended into a distinct point at the longest phalanx; order of length

of fingers 3–2–4–1, of toes 3–4–2–5–1; a groove extending backward from the eye meets a vertical groove behind the angle of the jaw; vomerine teeth eight on each side; maxillary teeth present; two strong recurved premaxillary teeth pierce the lip.

General color dark bluish gray, venter strongly pigmented, though lighter than dorsal area; a stippling of lichen gray spots, most developed on the sides; top of head with a conspicuous white spot behind the eyes, extending more obscurely forward to the tip of the snout.

Length to vent 41, head to gular fold 6.4, width of head 4.2, arm 6, leg 7.

Remarks.—Cope and Brocchi record *Oedipus vermicularis* from Guatemala, and Brocchi figures a specimen stated to be from that country; his description of white punctulation corresponds with the present specimen, but his figures of the hand and foot are inaccurate. The Guatemalan form with seventeen costal grooves is fully distinct from the Mexican *lineolus*, with fourteen; *Oedipus uniformis* and *O. collaris* have nineteen grooves; and the Panamanian *O. complex* and *O. parvipes*, with seventeen costal grooves, have a distinct basal constriction of the tail. The new form connects the distribution of the worm-like species of the genus in lower Central America with that of *lineolus* in Vera Cruz.

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